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Combining EUROMOD and LIAM tools for the development of dynamic cross-sectional microsimulation models : a sneak preview (*)

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Abstract

Several years ago, Cathal O'Donoghue has developed a tool for the development of dynamic cross-sectional microsimulation models : LIAM (Life-Cycle Income Analysis Model). The package has been extended and used in several countries, including Luxembourg, to build dynamic cross-sectional microsimulation models.

Regarding the tax-benefit system within such models, one possibility is to implement all needed modules directly following the LIAM framework. Another possibility is to compute benefits and taxes from outside the LIAM dynamic part of the model.

This contribution is a sneak preview of how such a combination is possible with the static EUROMOD model (Sutherland, 2007). The objective is served, on the one hand, by composing for the dynamic model a set of input variables closely related to the EUROMOD input dataset. On the other hand, the architecture underlying LIAM shows strong similarities with the one governing EUROMOD, making interactions easier.

The role of EUROMOD (or a module strongly related to EUROMOD) might be to take care (in an efficient and flexible way) of most tax-benefit computations, year by year, rather than developing on a separate basis specific modules in the dynamic model. These economies of scale might be of interest, especially (but not only) for little countries like Luxembourg. But a static model like EUROMOD could also take advantage of dynamic procedures made available.

1. Introduction

In a microsimulation sphere where tools become more and more sophisticated and better datasets and powerful programming software become available, it may be efficient to combine as far as possible existing models. This is peculiarly true for a country like Luxembourg where very small teams have to deal with such complex tools. Each of them can be developed up to their own limits, but this may imply doing twice the same kinds of tasks. An illustration is the tax-benefit component of the public policy which has to be implemented in all models as far as the distribution of net (or equivalised) disposable income matters.

Several years ago, Cathal O'Donoghue developed a toolbox for the development of dynamic cross-sectional microsimulation models : LIAM (Life-Cycle Income Analysis Model). The package has been extended by the Federal planning Bureau in Brussels (under management of Gijs Dekkers) and used in several countries, including Luxembourg, to build dynamic cross-sectional microsimulation models. Regarding the tax-benefit system within such models, one possibility is to implement all needed modules directly in the LIAM framework. Another possibility is to compute benefits and taxes using a model outside the LIAM dynamic part of the model.

This contribution is a sneak preview of how such a combination is possible with the static EUROMOD model (Sutherland, 2007). The EUROMOD static model and dynamic models built using LIAM show strong similarities regarding their contents and internal organization (*e.g.* discrete time oriented). The reason is clear: both are targeting close final objectives, the analysis of distribution of income and the impact of a change in the tax-benefit system (including *e.g.* "gainers" and "losers").

The role of EUROMOD (or a static module like EUROMOD) might be to take care in an efficient and flexible way of most tax-benefit computations, year by year, rather than developing on a separate basis specific modules in the dynamic model. The dynamic framework would then simply help in making endogenous the life events of the population (*e.g.* related to demography and employment status).

These economies of scale might be of interest, especially (but not only) for little countries like Luxembourg[1]. But a static model like EUROMOD might also take advantage of dynamic procedures made available.

This paper presents a first attempt to such combination of dynamic and static microsimulation models. And we are not working with the most recent versions of LIAM and EUROMOD.

On the one hand, we have DyMiLux, the Luxembourg dynamic microsimulation

[1] For example, the Italian Ministry of Finance is currently developing a dynamic model using LIAM. It is based on the Italian version of MIDAS and works in conjunction with the static model ECONLAV.

forward-looking population model, developed using the "former" LIAM toolbox[2]. This model is combined with EUROMOD version 31A. EUROMOD is continually being improved and updated[3] and the results presented here represent the best available at the time of writing. The EUROMOD module for Luxembourg will be fully updated by the end of 2011 only, in the scope of the EUROMODupdate project[4].

2. EUROMOD and LIAM microsimulation frameworks

The EUROMOD and LIAM microsimulation frameworks share several characteristics that can help in linking and combining those tools. Clearly, the architecture underlying LIAM shows strong similarities with the one governing EUROMOD[5], making interactions easier. We now describe the main features of the two platforms, underlying relevant technical aspects only.

2.1 The EUROMOD static microsimulation model

EUROMOD is an integrated European benefit-tax model for the (pre-2004) fifteen Member States of the European Union[6]. It allows us to easily derive, among several other indicators, the equivalised disposable income of households (a key instrument for the comparison of monetary characteristics) through an effective implementation of the structure of the population, the distribution of earnings, and the tax-benefit system (Bargain, 2007 and Sutherland, 2007). EUROMOD, like other microsimulation models, relies on microdata representative of a population (households and individuals) and can be used for the simulation and comparison of social policies. EUROMOD input database can be derived from administrative or survey data (Liégeois *et al*, 2010).

From a technical point of view, EUROMOD output is essentially based on two inputs: (a) household micro-data and (b) rules on how to calculate taxes and benefits described in several parameters files.

EUROMOD is static in the sense that population is fixed, taken as observed at a given point in time. The set of policies that have to be implemented in EUROMOD (listed in a so-called "spine" file and detailed in a "pol" file) can cover several years, adapting parameters and contents as needed (*e.g.* structural change in the tax-benefit system

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2 REDIS project (Coherence of Social Transfer Policies in Luxembourg through the use of microsimulation models) funded by the Luxembourg National Research Fund under Grant FNR/06/28/19.

3 We are indebted to all past and current members of the EUROMOD consortium for the construction and development of EUROMOD.

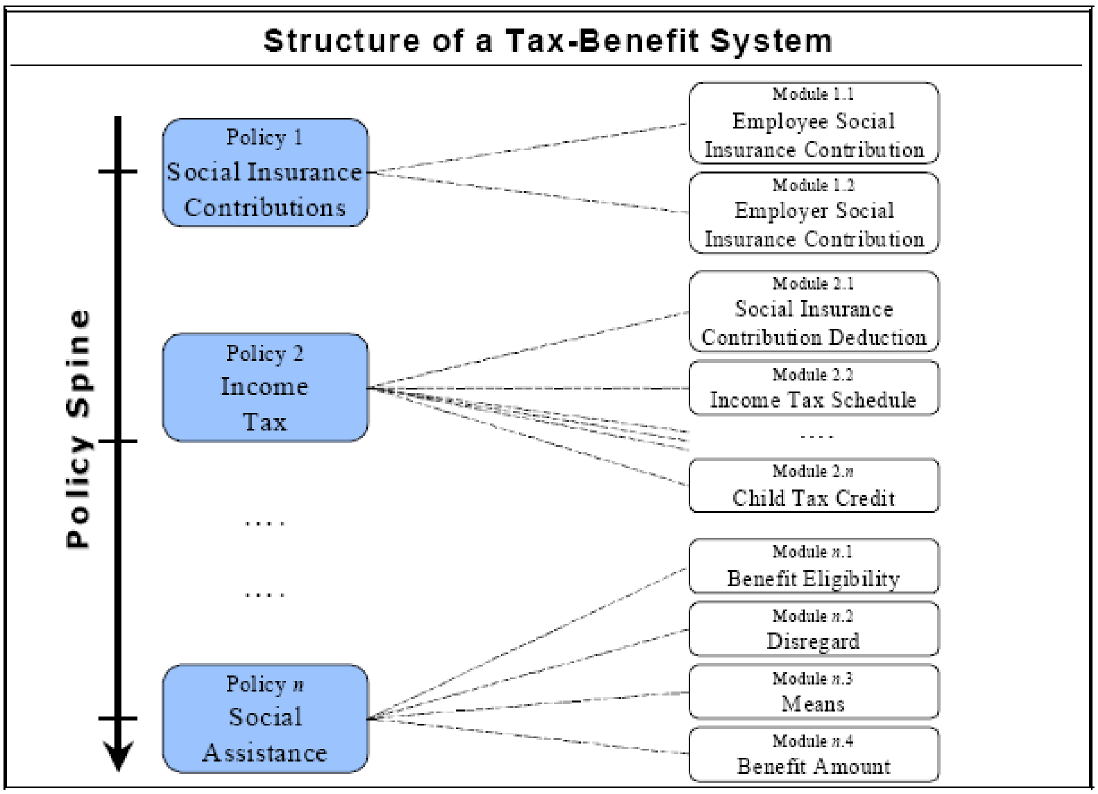
4 See http://www.iser.essex.ac.uk/euromod/developing-euromod/euromodupdate

5 This is not really surprising, given that one of the EUROMOD "parents" of LIAM is Cathal O'Donoghue, who initiated later on the development of the LIAM toolbox.

6 See http://www.iser.essex.ac.uk/msu/emod/

and/or monetary drift), but the population which is under consideration year after year is unchanged. This also makes a simulation in the longer term less sensible, given that an invariant population becomes a rather questionable hypothesis. The *Figure 2.1* makes more explicit the combination between the spine and policies in EUROMOD.

Figure 2.1 : The EUROMOD structure (spine and policies)



Source : Immervoll H and O'Donoghue C (2001)

We are considering here, as a basis, the Luxembourg resident population in 2008. EUROMOD input is derived from survey data, the Luxembourg household panel PSELL3[7]/EU-SILC[8] for 2008 (incomes from 2007).

The micro-data are described in a "vardesc" file and stored in a Microsoft ACCESS format, and read by EUROMOD through an ODBC link. This implies that, when several input databases have to be considered (*e.g.* corresponding to several

7 Panel Socio-Economique Liewen zu Lëtzebuerg; (http://www.ceps.lu).

8 EU-SILC is an instrument aiming at collecting timely and comparable cross-sectional and longitudinal multidimensional microdata on income, poverty, social exclusion and living conditions (see http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/eu_silc).

population years), an ODBC link and an ACCESS file must be created for each of them.

The parameters involve details about the policies to be implemented (*e.g.* computation of social contributions), described though the "spine" and "pol" files as written earlier, the description of population sub-groups (*e.g.* several kinds of households) in the "tu" file, and the definition of macro-income variables to be derived from input and simulated data (*e.g.* the so-called "disposable income" of a residence household) made in the "il" file. As mentioned already, policies can vary through the period of time to be considered (a "system" is then designed for each year).

Finally, the whole EUROMOD procedure is governed through a "control" file.

< EXAMPLES OF CONTENTS / PARAMETER FILES >

2.2 The LIAM framework for dynamic microsimulation

The Life-Cycle Income Analysis Model (LIAM) is a flexible framework for the creation and the simulation of dynamic microsimulation models (O'Donoghue, 2009). It was created by Cathal O'Donoghue and later developed and completed to build up the dynamic microsimulation model MIDAS (« Microsimulation for the Development of Adequacy and Sustainability » of pensions systems) for Belgium, Germany and Italy (Dekkers et al., 2008). Based on such a framework, the dynamic microsimulation forward-looking population model DyMiLux has recently been developed for Luxembourg. The process is still going on, and at time no tax-benefit structure was created yet. Moreover, the model has not been fully validated up to now, which makes economic and social interpretation of the results more difficult.

In addition to a static framework like the one implemented in EUROMOD, DyMiLux incorporates, on the one side, the time dimension regarding life events. Population is "aged" and recomposed (*e.g.* marriage) while time passes and the employment status is endogenously determined (*e.g.* employment-unemployment transition). These changes are either deterministic (*e.g.* "age + 1") or randomly determined with a probability for an event to occur depending on personal and household characteristics or not. The population dimension is then more properly taken into account in such a framework.

On the other side, all information needed for the determination of taxes and benefits should be simulated or given as an input to the model through time. If not simulated (*e.g.* rents), the content of a variable might lose some relevance in the longer term, if maintained to its initial value. The degree of "detail" we can afford in dynamic model, regarding the tax-benefit side, is then poor compared for example to EUROMOD.

Similarly to the EUROMOD-side, we are considering here, as a starting dataset, the Luxembourg resident population in 2008. DyMiLux input is then derived from survey data, the Luxembourg household panel PSELL3/EU-SILC for 2008[9].

Table 2.1 : A first comparison of EUROMOD and LIAM environments

	EUROMOD_based	**LIAM_based**
PROCEDURES / CONTROL		
General control	control.txt	dycontrol.txt dyrunset.txt
List of procedures/policies	spine.txt	agespine.txt
Description of procedures/policies	tran<…>.txt trap<…>.txt (al_)regr<…>.txt	pol<…>.txt
DATA		
Input dataset format	MS-ACCESS & ODBC	<VARNAME>.txt, objtype.txt *(individuals, households)* and linkage.txt *(between individuals, individuals and households)*
List of and main characteristics of variables	vardesc.txt	dyvardesc.txt
Output dataset	TXT or STATA format	TXT format

The dynamic microsimulation is governed in LIAM through several files that often sound similar to those involved in the EUROMOD procedure : general control with a "dycontrol" file, list of tasks (*e.g.* policies) to be simulated year after year with "agespine", description of variables in "dyvardesc" file, *etc*. The *Figure 2.2* makes more explicit some contents of the agespine, in relation with the life events of the population.

LIAM output is mainly offering micro-data regarding household composition, employment status and incomes, all those characteristics being delivered through time. Those data are stored in TXT or STATA format.

The *Table 2.1* can help in comparing the two modeling frameworks.

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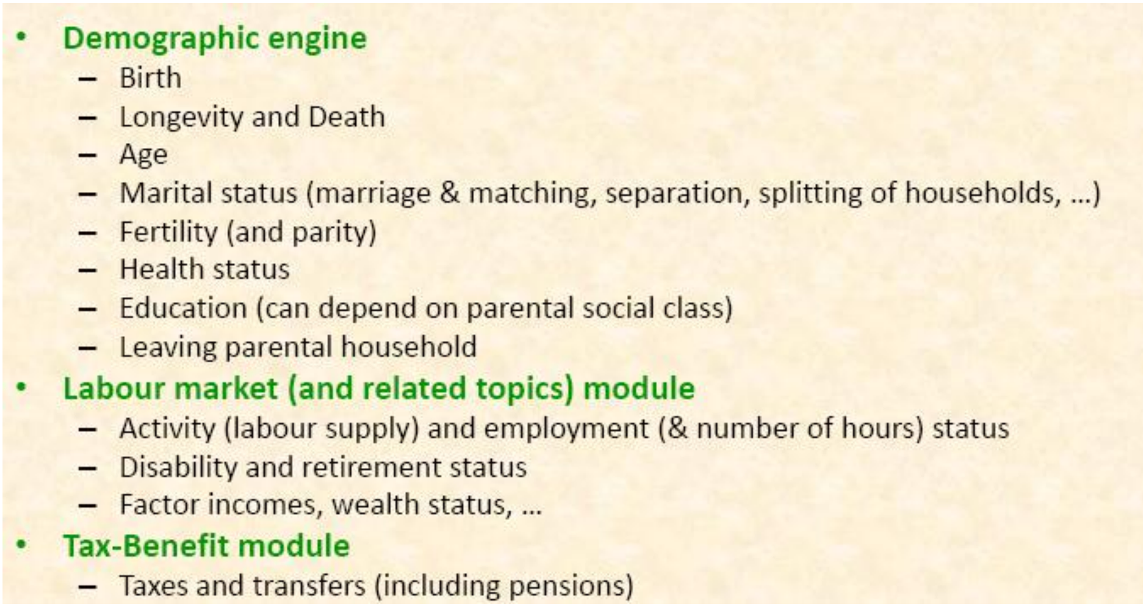
9 Other SILC waves are also considered in order to derive "behavioral" contents (e.g. probabilities of transitions, given personal and households characteristics) for the model.

Figure 2.2 : The EUROMOD structure
(spine and policies)



3. Combining EUROMOD and LIAM

Building on output from DyMiLux, encompassing household composition and individual characteristics (including gross labor income), we show now how EUROMOD can be used for the tax-benefit computations. Of course, those computations might be directly performed within the dynamic framework, but we remind that completing the dynamic model in such a way is a rather demanding task (not performed for Luxembourg yet) and the objective of the present paper is to show *how* linking EUROMOD and LIAM more than *why*.

The objective is to start from the description of a population given for an initial year under consideration (2008, incomes from 2007) and derive the distribution of disposable income for the "same" population[10] in the future. The present exercise is covering years 2008-2018, but might be easily extended.

For each year passing (one only if static framework), households are examined in turn, life events are simulated (dynamic framework only) and taxes and benefits computed (static framework). Finally, income is derived and the distribution of "well-being", whatever the definition, can be examined. These are the main lines governing the interchange between EUROMOD and DyMiLux.

Of course, since this paper describes a first attempt to interlink the two models, their 'dialogue' is yet incomplete. In the Luxembourg case, the dynamic model DyMiLux,

[10] Nevertheless progressively « aged »

developed in the LIAM framework, was written with the EUROMOD input set of variables in mind. Sometimes, the definition of variables had to be changed (for example, when categories defined in EUROMOD were not fully appropriated for a dynamic simulation given specific constraints). And some variables, made necessary in the dynamic framework, had to be added. However, the final "static" and "dynamic" datasets are still close enough to make the output of DyMiLux a possible input for EUROMOD.

The *Table 3.1* summarizes the steps needed for the exercise, if EUROMOD is used after DyMiLux for the tax-benefit side of the computations.

Table 3.1 : Towards a link between EUROMOD and LIAM platforms

Steps	Task	Remark
1	Preparing input dataset for DyMiLux (LIAM)	Mainly based on PSELL3/EU-SILC 2008 (incomes from 2007)
2	Running DyMiLux	STATA Outputs (households and individual characteristics, incomes) for years 2008, 2009, etc. (up to 2018 in the present exercise)
3	Preparing inputs datasets for EUROMOD	- A few variables have to be redesigned (when definitions inconsistent in static and dynamic frameworks) - One MS-ACCESS dataset for each year, together with its ODBC link
4	Preparing parameter sheets for future public policies in EUROMOD	- Mainly "pol" files concerned, but also "control" file and possibly "tu" and 'il" files (see *Section 2.1* and *Table 1*)
5	Running EUROMOD	TXT outputs
6	Analysis of results	Based on years 2008 - 2017

DyMiLux is run, deriving population structure (individual characteristics and household composition) in the forthcoming years and gross labor incomes. In the present exercise, we consider a consumer price indexation of 2.5% per year and some real growth for the hourly-wage.

After running DyMiLux, the output from the dynamic model is used to generate several input files for EUROMOD. One input MS-ACCESS dataset and its ODBC link is needed for each year under consideration. Sometimes, variables[11] must be

[11] For example, the *"Highest Education Achieved"* variable is categorized [*"COEDUACH"* : (0) Not completed primary level, (1) Primary, (2) Lower secondary, (3) Upper secondary, (4) Tertiary] in EUROMOD, to be compared to [(0) Do not know, (1) Up to lower secondary, (2)

recomposed in order to conform to the EUROMOD framework, as written earlier.

Then, public policies must be anticipated and parameterized in EUROMOD, which is done through "pol" files[12]. In the present exercise, we are considering a simple evolution. New policy "systems" are created for the years 2008-2018. Regarding income taxation, a change of tax brackets is introduced, conform to the consumer price indexation : +2.5% per year. Family allowances are imposed a one-shot increase by 13.1% (2.5% to the power 5) in 2013. The so-called "Minimum Social Wage" is indexed taking into account both consumer price index and the real growth rate of hourly-wage[13]. This reference is playing a important role in the determination of many tax-benefit amounts (*e.g.* for the computation of social contributions whose tax-basis is top-limited to 5 times the Minimum Social Wage). Finally, social assistance is also indexed on prices.

At the end, EUROMOD is run and results can be examined for deriving the income distribution in the future.

4. Analysis of results

We can show now a few results from combined simulations described earlier and emphasize the impact of completing a model with another.

Section 4.1 makes more explicit the simulation scene and its limitations. Then, *Section 4.2* gives details about the population changes over the period 2008-2018 and their impact, together with that of policy reforms, on the distribution of equivalised disposable income and inequalities.

4.1 The global simulation scene and limitations

While combining EUROMOD and DyMiLux (LIAM) models, we are in position to make both population (including gross income) and policies ("systems", in EUROMOD) evolving, either together or separately.

Starting with the Luxembourg household panel PSELL3/EU-SILC, an input dataset is composed for DyMiLux which refers to population in 2008 and income in 2007. Priority is given to the income year concept and this dataset is said to "cover" the

Lower than tertiary, (3) Tertiary] in DyMoLux. The *"Employment Status"* is not available from DyMoLux as such and must be derived from other DyMoLux output variables ("inwork", "employee", "unemployed", etc.). Finally, other variables are simply not simulated in DyMoLux, like the *"Maintenance payments - COMAINTY"* or the *"Housing tenure - COTENURE"*.

[12] Other important files including the "spine", "tu" (tax units) and "il" (income lists) might have been affected as well. However, we are considering a simple scenario which does not imply any change in those files. Of course, we need a "control" file for each input dataset.

[13] Minimum Social Wage = € 1,609.53 per month as of 1 March 2008.

"year" 2007. DyMiLux is then run and generates outputs for the years 2008 to 2018. Those results include information about the population and the labor gross income. It is reminded that, at present, nothing more is made available through DyMiLux. Other sources of revenue, like unemployment benefits, pensions[14], *etc* are not generated through DyMiLux. Given that those resources are not simulated in EUROMOD either, they are simply ignored here.

Another limitation is due to the transition between an input which is observed data, (year 2007) and the first output year involving simulated results, including the population characteristics (year 2008). This is the reason why we choose the year 2008 and the first DyMiLux output wave as the reference point both for the analysis of results and for the EUROMOD starting input. Successive waves will be compared to that basis.

Moreover, it was not possible to take "weights" of households (and individuals) into account in the dynamic model[15]. Then, weights are simply ignored in the whole process, departing from what is naturally feasible in EUROMOD and what should be normally done given the survey nature of raw data.

Finally, DyMiLux is generating households based on specific rules. For example, an adult may be forced to leave his parents' household after a certain age, whatever his status elsewhere, which prevents the model to deal with complex residence households (several generations living together). This leads to a population configuration in terms of "nuclear" households rather than "residence" households[16] which are the standard reference basis[17]. A nuclear household is composed of the parent(s), lone or in couple, whatever married or not, and "dependents" (mainly

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[14] Pensions, like other kinds of resources, raise a few additional difficulties. Like many other countries, those benefits depend on past history of the recipient (and maybe that of his/her relatives), including incomes and working periods of time. Such cumulative individual variables are not generated in DyMoLux model yet (this will change soon for "new" individuals) and then not made available for EUROMOD simulation here. Moreover, the question whether a feedback from EUROMOD to DyMoLux might be needed, is still to be explored.

[15] We could reintroduce "weights" while coming back to EUROMOD. However, the dynamic nature of the whole exercise makes necessary to determine a weight for households and individuals newly generated in the dyamic model as well ! See also Dekkers and Cumpston (2011) for more recent suggestions about the "weighting" process.

[16] For a discussion about "residence", "nuclear" and "fiscal" households (unmarried parents, even from the same nuclear family, may belong to seperated fiscal households), see Liégeois *et al.* (2010). In luxembourg, it is shown that 20% of residence households are composed of more than one fiscal households (PSELL3/EU-SILC 2004).

[17] This plays an important role for the computation of the equivalised disposable income, involving a total disposable income and a weighted load determined at the level of the (normally residence) household. In Luxembourg, social assistance may also be mean-tested based on the reality of the whole residence household. Then, working exclusively with nuclear families can significantly change the scene. See Liégeois *et al.* (2010) for more details.

young children).

Those limitations, together with the lack of validation up to now (see *Section 2.2*), explain why we should avoid evaluating what will be produced in the present paper with other literatures differently grounded. In particular, we must remember that the world built here through our simulations is rather incomplete in economic and social terms and then biased with that respect. However, even if such limitations are important, they are less damaging regarding the present exercise which is supposed to concentrate on the technical question of the combination between the static and the dynamic platforms EUROMOD and LIAM.

From DyMiLux outputs 2008-2018, input datasets are created for EUROMOD which can finally be run. Given the limits mentioned *supra*, those EUROMOD inputs are restricted compared to what is done in usual EUROMOD simulations (which take into account pension benefits, for example).

4.2 Population changes and evolution of inequalities

Given our specific scene and parameters chosen for the DyMiLux model in the present exercise, we can see from the *Table 4.1* that demographic changes through time are important.

Not surprisingly, population is progressively aging[18]. It is also moving towards more single-type (nuclear) households, with fewer dependents per household, on average.

Further those demographic changes, income is evolving (through real and nominal growth of the hourly wage and due to individual choices –behavioral contents- and life events) and the public policy is progressively adapted (see *Section 3*).

Among those three impulses, two are here dealt with by the dynamic model (population, gross labor income), the last one through static microsimulation (public policy). Even if EUROMOD is conceived so as to take monetary evolution of income elements somewhat into consideration, thanks to its "uprating" procedure (nominal and real inflation of monetary variables), behavioral contents are limited. In the present configuration, we have then chosen to work with income on the dynamic side of the scene, rather, so that behavioral and inflating (nominal and real) elements playing a role in the determination of total gross income are dealt with at once.

Disentangling the relative impacts of all those influences is a difficult task and we emphasize now a few indicators and methods that might help both in interpreting the results in economic and social terms and in understanding what is happening on (and the impact of) the modeling scene. We are concentrating on the distribution of

[18] However, the rapid evolution observed might be questionable. The validation of the model will help understanding more about that and might induce adaptations (see *Section 2.2*).

equivalised disposable income[19].

Table 4.1 : Characteristics of the population and changes

Characteristics	Categories	2008	2013	2018
Age (in proportion of INDIVIDUALS)	Age < 18	27%	26%	23%
	18=< Age < 59	59%	56%	55%
	Age >= 60	14%	18%	22%
Type of household (in proportion of sociological HOUSEHOLDS)	Single (< 65)	20%	28%	34%
	Single (65+)	6%	7%	8%
	Single with dependent(s)	9%	11%	14%
	Couple 0 dep	23%	20%	20%
	Couple 1-2 dep	33%	25%	17%
	Couple 3+ dep	10%	9%	7%
Number of dependents [*] (in proportion of sociological HOUSEHOLDS)	0 dependent	49%	55%	62%
	1 dependent	22%	20%	18%
	2 dependents	19%	15%	11%
	3+ dependents	11%	11%	11%

Source : DyMiLux and own computations (CEPS/INSTEAD)
(*) A dependent is a member of a nuclear household but not a parent (*e.g.* young child)

On the whole, it can be seen for example from the *Table 4.2* that inequality is increasing through time in our exercise, with a change in Gini coefficient[20] from 0.2531 to 0.2815 between 2008 and 2018, and the same kind of qualitative evolution regarding the poverty rates, Atkinson indices[21] and Inter-quartile or –decile

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[19] As is well known, the equivalised disposable income is the ratio of total disposable income (= earnings – social contributions – taxes + social benefits, all summed up for all members of the household) to the equivalent weight of the household. We follow the 'OECD-modified scale' and assign a value (weight) of 1 to the household head, a value of 0.5 to each additional adult member, and 0.3 to each child (younger than 14). The equivalised disposable income is evaluated at the household level. Each member of the household is then attributed this (common) value of equivalised disposable income.

[20] For a detailed presentation of social indicators, see Atkinson *et al*. (2002) and Marlier *et al*. (2007).

[21] The Atkinson inequality index can be expressed as $(\varepsilon) = 1 - \left[\frac{1}{n} * \sum_i \left(\frac{x_i}{\mu}\right)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}$, where *n* is the number of individuals, x_i is the income level, μ is the average income, and ε is the inequality aversion coefficient. It takes a value between 0 (minimum inequality) and 1 and can be interpreted in terms of social welfare; it shows that part of total income which might be saved, while keeping the social welfare (associated to the Atkinson index) unchanged and distributing the remaining disposable income equally. The higher the value of ε, the stronger the impact of the left side of the distribution on the index. See Essama-Nssah (2000) and Lambert (1993).

ratios[22] (see lines "POL-POP").

Table 4.2 : Inequality indicators, impact of modeling and evolution

Inequality indicators	**Configuration** (II)	**Year** (I)		
		2008	**2013**	**2018**
Gini	POP_2008	0.2531	0.2452	0.2389
	POL_2008	0.2531	0.2752	0.2983
	POL_POP	0.2531	0.2667	0.2815
Poverty rate (60% of median equivalent income)	POP_2008	14.6%	9.0%	4.0%
	POL_2008	14.6%	18.1%	18.9%
	POL_POP	14.6%	15.8%	18.7%
Atkinson index (inequality aversion = 0.5)	POP_2008	0.050	0.047	0.045
	POL_2008	0.050	0.061	0.072
	POL_POP	0.050	0.057	0.063
Atkinson index (inequality aversion = 2)	POP_2008	0.175	0.163	0.153
	POL_2008	0.175	0.207	0.241
	POL_POP	0.175	0.193	0.210
P75 / P25	POP_2008	1.99	1.98	1.98
	POL_2008	1.99	1.90	1.92
	POL_POP	1.99	1.89	1.92
P90 / P10	POP_2008	3.09	2.90	2.73
	POL_2008	3.09	3.54	4.13
	POL_POP	3.09	3.28	3.54

Source : DyMiLux, EUROMOD and own computations (CEPS/INSTEAD)

(I) INCOME year

(II) *"POP_2008"* : POPULATION (including original gross labor INCOME) invariant through the 3 simulations, value 2008 ; POLICY evolving through time
"POL_2008" : POLICY invariant through the 3 simulations, value 2008 ; POPULATION, including original gross income, evolving
"POL_POP" : POPULATION and POLICY changing throughout time

While simulating the EUROMOD model in order to get a more comprehensive view of

[22] The Gini coefficient takes a value between 0 (minimum inequality) and 1. If we define the social welfare as $W(x) = \frac{1}{n^2}\sum_i \sum_j min\{x_i, x_j\}$, then it can be shown that $W(x) = \mu * (1 - G)$, where n is the number of individuals, $x_{i/j}$ is the income level, μ is the average income, and G is the Gini inequality index. See Essama-Nssah (2000) and Lambert (1993).

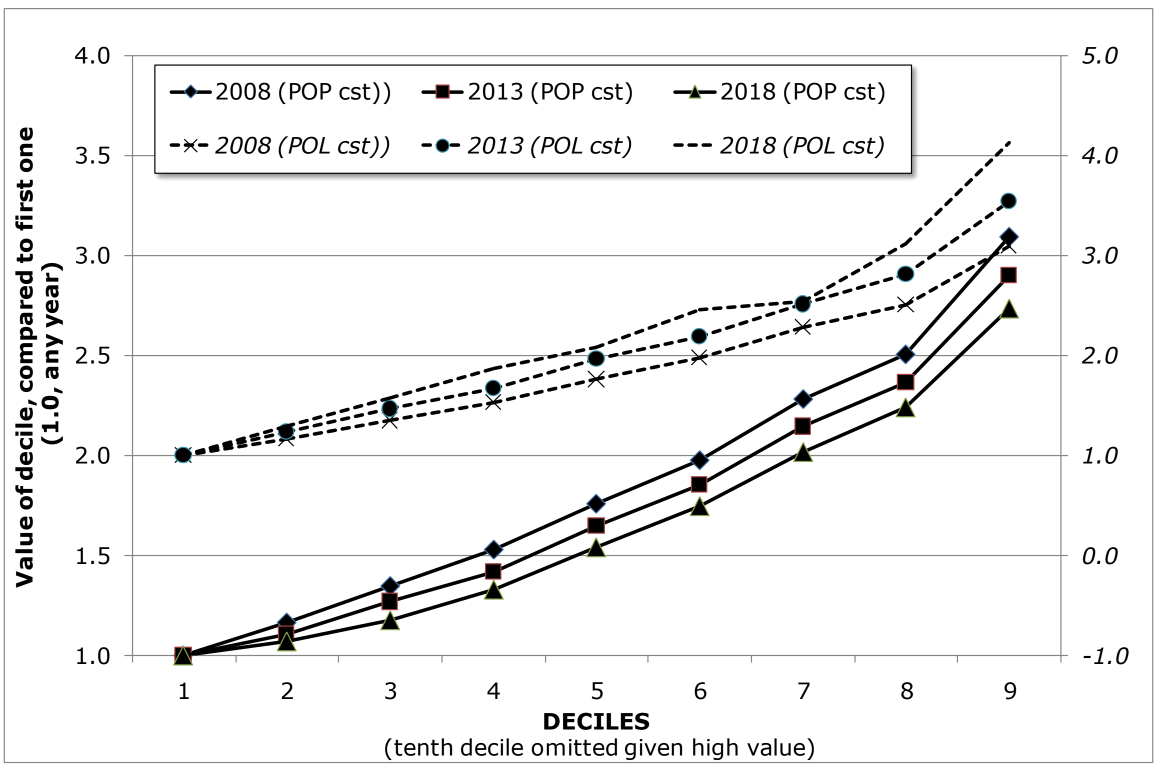
the socio-economic status of the population (dynamically "generated" through DyMiLux, together with labor income), we can choose to fix the population and change only the policy to be implemented. This is the EUROMOD-intrinsic way to proceed (out of the uprating procedure for monetary variables, not used here), even if some marginal adaptations can be imagined on the population-side through time as well. The lines "POP_2008" in the *Table 4.2* show the results under such a scenario, with policy systems implemented as announced for 2013 and 2018.

But we can also change the population, taking fully into account the DyMiLux indications, while keeping invariant the public policy under study. The lines "POL_2008" in the *Table 4.2* refer to that. The public policy implemented for 2008 is unchanged throughout time and population and gross labor income, only, are changing.

Figure 4.1 : Evolution of income distribution through time

Full lines refer to the "population constant" and left axis

Dotted lines refer to the "policy constant" and right axis



Source : DyMiLux, EUROMOD and own computations (CEPS/INSTEAD)

What can be observed is that if both dimensions, the population-one and the policy-one, are playing a role in the whole transformation, their contribution can happen to be opposite, regarding a few indicators. Taking into account the change in policy only (population constant) induce a drop in inequalities (for example, Gini going from 0.2531 down to 0.2389), with a significant impact on the left-side of the income distribution (see the Poverty rate or Atkinson indices). Focusing on the population changes, rather, while keeping invariant the public policy, drives the whole system in the opposite way : inequalities are deepened. The *Figure 4.1* is illustrating the observation another way. The distribution of income in terms of deciles is represented, and its evolution trough time under the two regimes (policy *versus* population constant) emphasized.

<SEE WHY, IN TERMS OF CONTENTS OF POLICIES, WITH TAX BRACKETS, FAMILY ALOWANCES, MINIMUM SOCIAL WAGE AND SOCIAL ASSISTANCE, MODIFIED>

Table 4.3 : Inequality indicators, evolution and impact of modeling

Inequality indicator	**FIRST step** (changing POLICY)		**SECOND step** (changing POPULATION)	
	FROM : POP_2008 … and POL_2008 (I)		**FROM :** POP_2008 and POL_2013	*… or POL_2018*
	TO : POP_2008 and POL_2013	*… or POL_2018*	**TO** : POP_2013 & POL_2013 …	*… or POP_2018 & POL_2018*
Gini : initial (1)	**0.2531**	0.2531	0.2452	0.2389
Gini : Final (2)	0.2452	0.2389	**0.2678**	0.2814
Gini : Initial - Final (3) = (1) - (2) = (4) - (5)	0.0079	0.0142	-0.0226	-0.0425
Reynolds-Smolensky index of vertical equity (4)	0.0081	0.0148	0.0515	0.0805
Re-ranking index of horizontal inequity (5)	0.0002	0.0006	0.0741	0.1229

Source : DyMiLux, EUROMOD and own computations (CEPS/INSTEAD)

(I) See note (II), *Table 4.2*

This opposite contribution can be enlightened still another way. In the *Table 4.3*, the transition from 2008 to 2013 (respectively 2018) is made two-steps. In a first (intellectual) movement, the policy system is changed, while the population is maintained at its 2008-level. The second step completes the first one in order to reach the final population-2013 (resp. 2018) - policy system-2013 (resp. 2018) configuration. Not surprisingly, one again, the first step (policy change) induces an inequality reduction while the second step (population change) is just doing the contrary. Both steps involve some vertical redistribution[23], but in the second one, an important horizontal redistribution[24] is observed, which more than compensates for the vertical effect, leading to an increase in inequality as measured by the Gini coefficient.

All those considerations underline the importance to take all kinds of effects and evolutions into account, even if in the present exercise, population changes might be seen as somewhat too severe[25].

5. Conclusions

This paper discusses a first attempt to associate the static model EUROMOD with the dynamic DyMiLux model.

Regarding incomes, taxes, benefits, inequalities and redistribution in the near and longer terms, EUROMOD, on the one side, is well-suited to deal with changes in the tax-benefit system. It can also incorporate some change in the monetary variables through the "uprating" procedure. On the other side, DyMiLux can take into consideration behavioral reactions (*e.g.* a varying labor supply), population changes and monetary evolutions as well.

So the first conclusion is that the combination of the two models is indeed possible, which was the main issue raised by this paper. However, the combination still suffers from some restrictions that confine the possibilities at this stage. At present, we are missing a few variables, especially as far as longer term projections are the objective. In the EUROMOD environment, such an information, if not simulated, can be sometimes partially derived from raw input data (PSELL3/EU-SILC) and maintained constant for a few years projection when needed. But this option of invariance is less valid in the longer term. The role of a model like DyMiLux is to produce values for those dimensions, but still a few are left aside (*e.g.* capital income, replacement revenues like pensions, *etc*). Of course part of this limitation is purely contextual and will disappear in the future, when DyMiLux will have been progressively completed.

Moreover, the dynamic model can generate nuclear households only and does not deal with "weights" of households and individuals, which makes a strong limitation regarding social indicators that should be set on the basis of residence households

[23] Vertical redistribution consists of reducing inequalities of equivalised income between households who have the same structure but a different income level.

[24] Horizontal redistribution consists of reducing inequalities of equivalised income between households who have the same income level but a different structure.

[25] The validation of the DyMoLux dynamic model, to be completed, will tell more about the point.

and in a “weighted” configuration.

Finally, an initial gap can exist between the first-year generated population in DyMiLux and the characteristics of the population as observed in the data used to feed the model (but the question needs to be developed further, through the validation process of the dynamic model which is not completed yet).

We show also that population (including the question of gross income) and tax-benefit dimensions can play a role in an opposite way, regarding the distribution of equivalised disposable income and inequalities. In the present exercise, inequalities are shown to decrease between 2008 and 2018 due to policy changes. But population transformations play a significant role and induce rather an increase of inequalities which even overcome the policy effect, leaving a situation where the society is more unequal in 2018 than in 2008. All those considerations underline the importance to take all kinds of effects and evolutions into account.

Of course, further developments would be needed for understanding in details what is happening in the background. In particular, the way we proceeded cannot tell us enough about the limits of the two models and their relative contribution, given that we have chosen to deal with the question of monetary gross income through DyMiLux exclusively, even if EUROMOD could have been used up to a certain point for that purpose.

Finally, an important step will be to undertake a combination of the latest versions of the two models. On the one side, EUROMOD is being updated at the moment (in the scope of the EUROMODupdate project) and the new model will be available for Luxembourg around the end of the year. This new version also involves a new interface for the programmers. On the other side, DyMiLux is built through the LIAM toolbox, as it was implemented initially by Cathal O’Donoghue and completed by the Federal Planning Bureau in Brussels. Today, a new fully redesigned toolbox, “LIAM-2”, is being developed in the scope of the MiDaL project. LIAM-2 will incorporate many changes regarding the internal organization of models built on that basis and IT-technical aspects. All this will have to be explored further regarding the present exercise of combination.

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